



Dipl.-Ing. Florian Schoewel, Dipl.-Ing. Elmar Hockgeiger
BMW Group, München

THE HIGH VOLTAGE BATTERIES OF THE BMW i3 AND BMW i8.

AABC 2014, FEBRUARY 3TH- 7TH, ATLANTA

**BMW
GROUP**



advanced
automotive
battery
conference

aabc

AGENDA.

- **BMW approach to sustainable mobility: BMW i**
- **Project targets and requirements**
- **Technical concepts and solutions**
- **Summary**

BMW i - SUSTAINABILITY DRIVES THE LIFECYCLE.

New vehicle concepts



New materials and recycling



Production concept of the future



New electric drivetrain



Integrated approach of BMW i – BORN ELECTRIC.

New processes



Employees



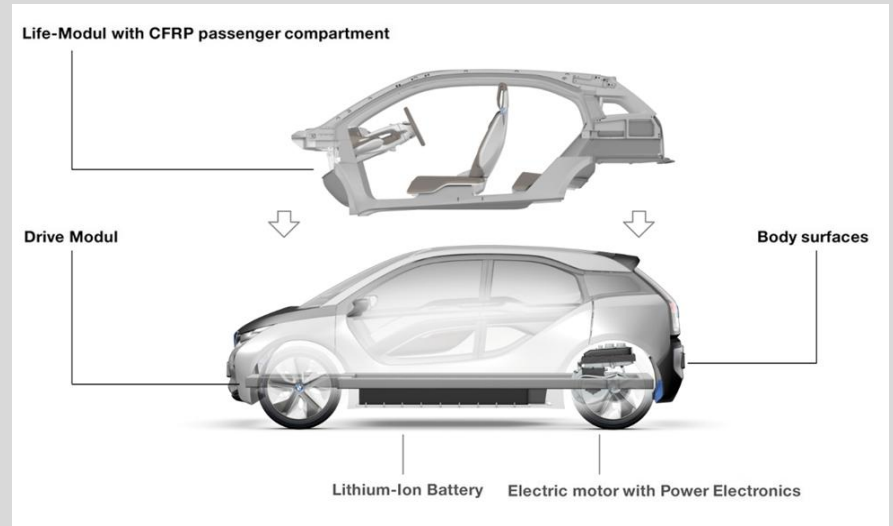
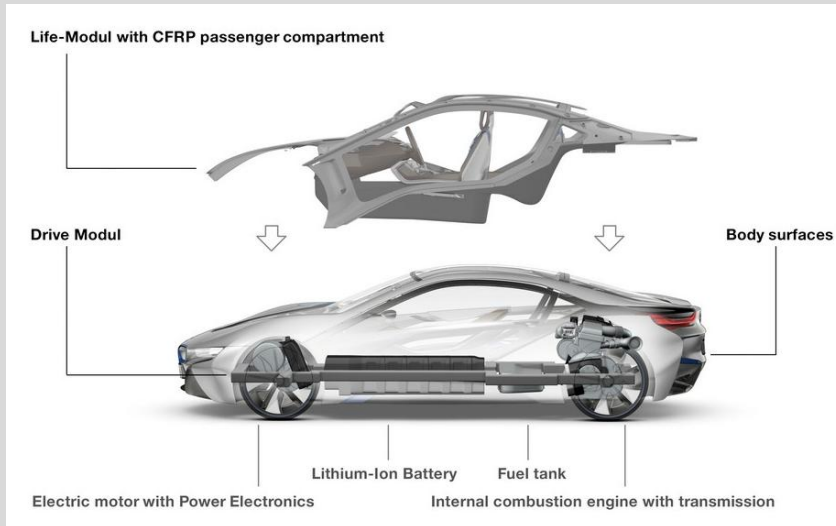
Pioneering design



New customer focus



THE PURPOSE DESIGN LIFEDRIVE CONCEPT.



Two separate, independent functional units:

- **Life module**

High-strength and extremely lightweight passenger cell made from carbon fibre-reinforced plastic

- **Drive module**

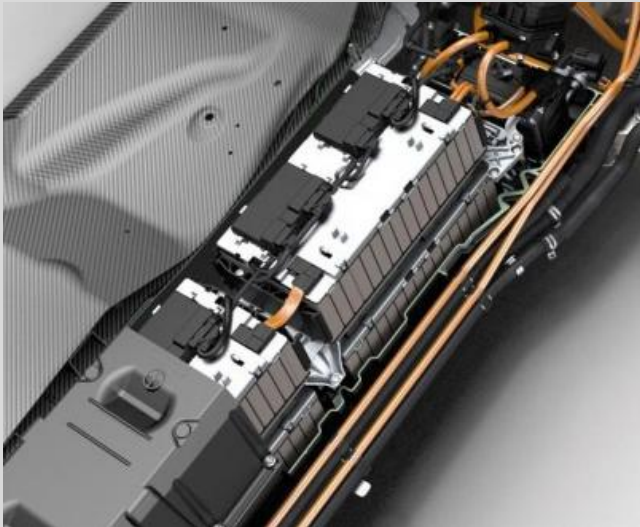
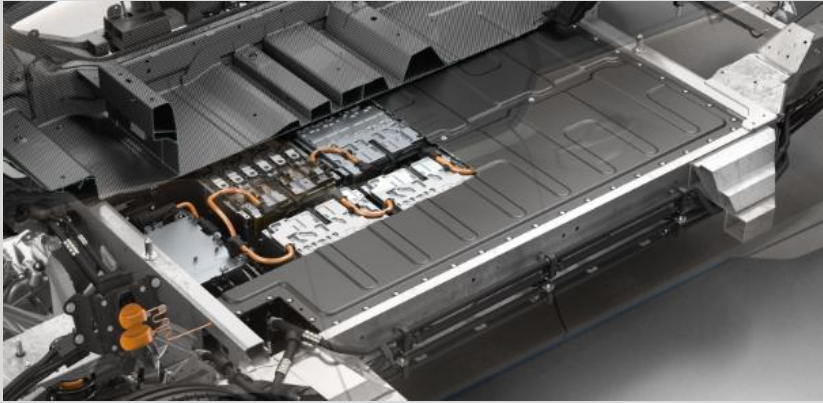
Ideal integration of suspension and eDrive System

ELECTRIC POWERTRAIN : THE BMW eDRIVE SYSTEM.



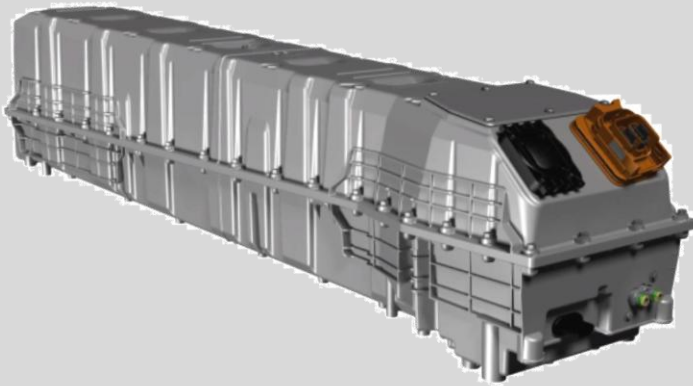
- **In-house development**
Key components developed at BMW (power electronics, electric motor and high voltage battery)
- **In-house production**
Electric motor and high voltage battery assembled at BMW
- **High efficiency**
Increase range and reduce battery costs
- **Low weight**
In accordance with the light weight concept i3

REQUIREMENTS FOR THE HIGH VOLTAGE BATTERIES.



- **High power density**
Enabling BMW typical driving dynamics
- **High efficiency & low weight**
Increase range and reduce battery costs
- **Lifetime**
Battery warranty of 8 years
- **Safety**
No risk in any situation
- **Sustainability**
Choice of materials & second life use

BMW HIGH VOLTAGE BATTERIES : TECHNICAL DATA.



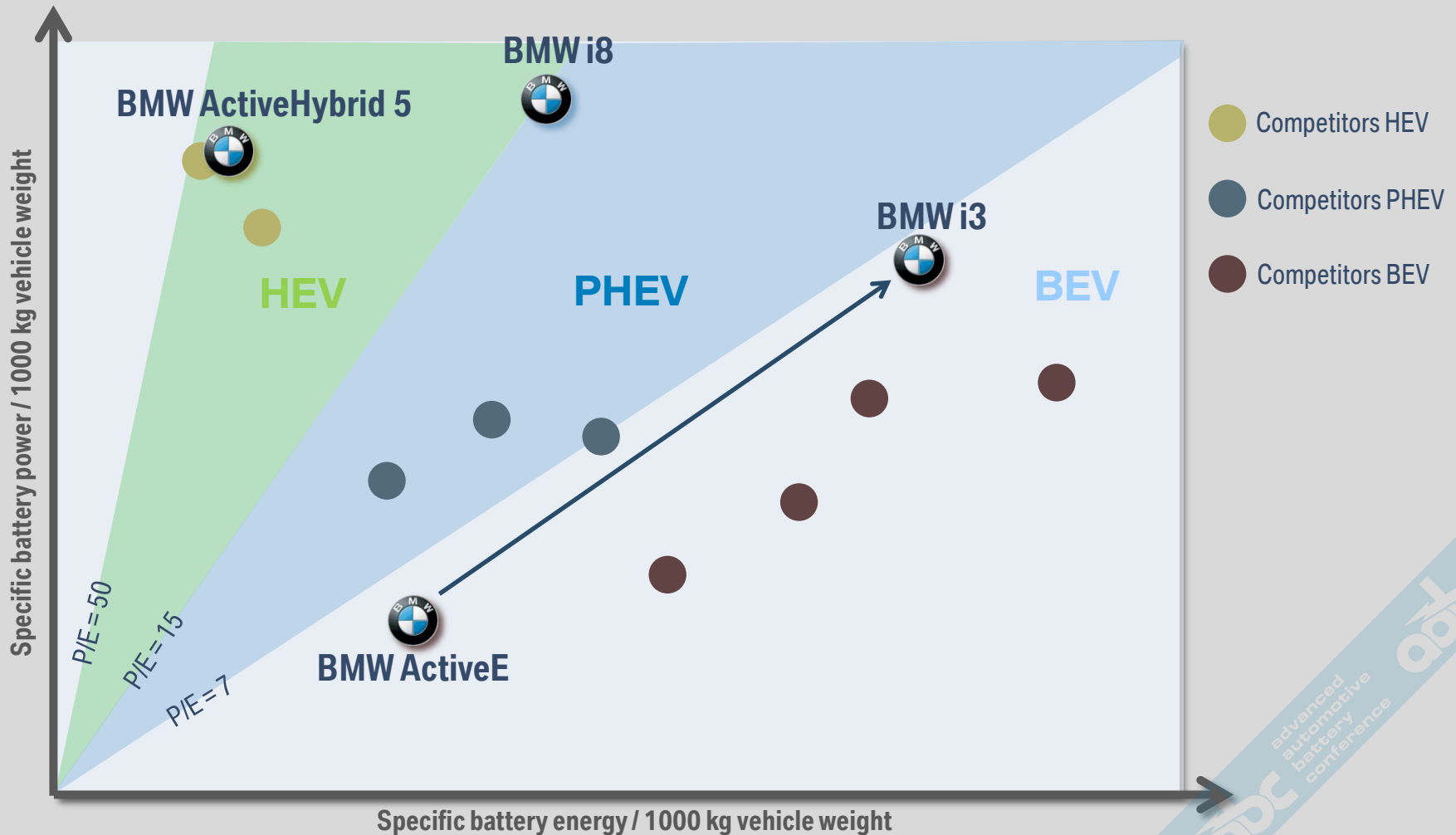
BMW i8 high voltage battery



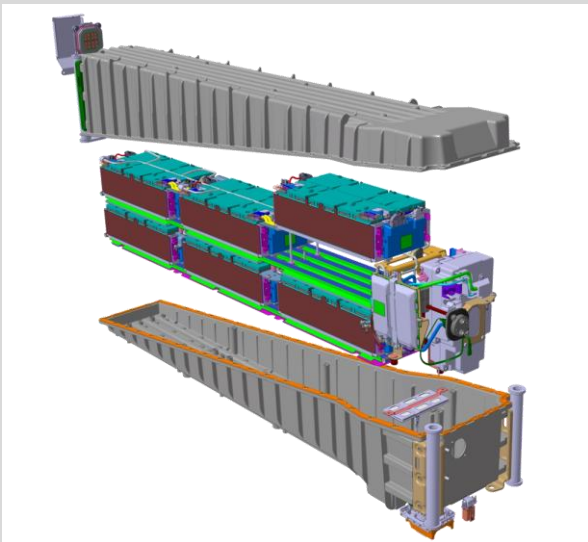
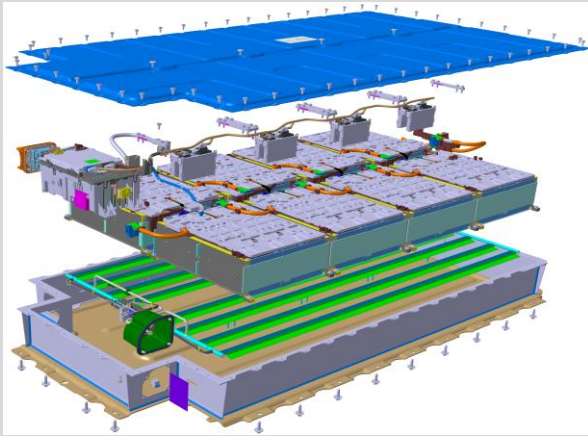
BMW i3 high voltage battery

Technical Data	BMW i3	BMW i8
Nominal voltage	360 V	355V
Max. current	409 A	320A
Energy content	22 kWh	7.1 kWh
Discharge Power peak	147 kW	105kW
Total number of cells	96 (1p, 96s)	
Weight (with connections)	233 kg	98 kg
Charging time	<0,5 h for 80% (DC charge)	2h (AC charge)
Cooling	Refrigerant	

BMW BATTERY SYSTEMS HAVE A UNIQUE POSITION IN TERMS OF POWER / ENERGY DENSITY.



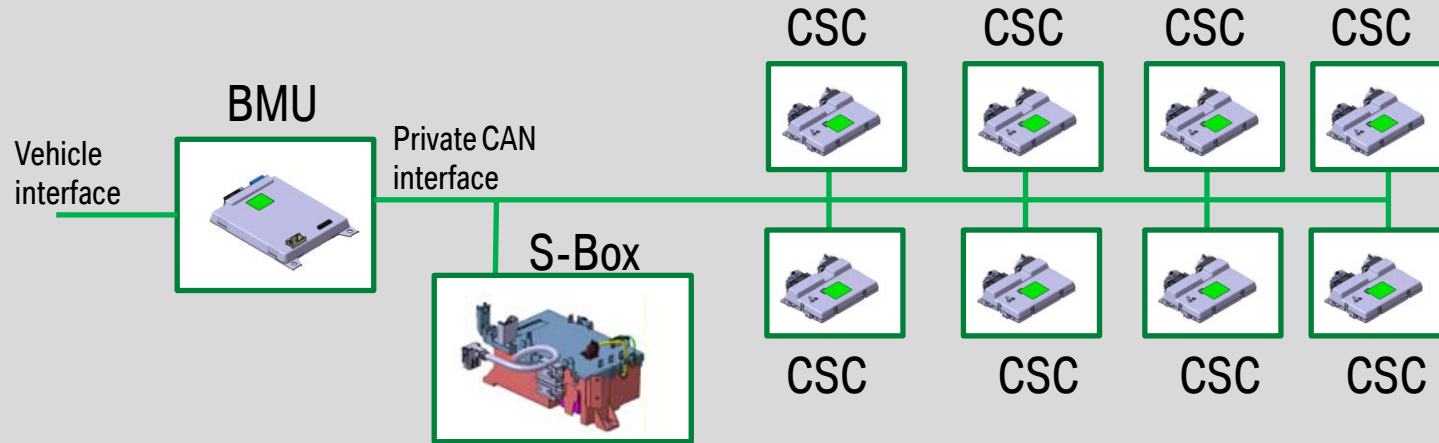
TECHNICAL CONCEPT – BATTERY PACK.



Concept identical for PHEV / EV application

- Distributed E/E design (BMU, S-Box, CSC)
- Structural rigidity by overall mechanical design
- Light-weight housing (aluminum extruded/diecast)
- Direct refrigeration (single/multi-layer)
- All components serviceable, easy access, (high voltage is protected against contact within battery housing)

TECHNICAL CONCEPT – E/E.

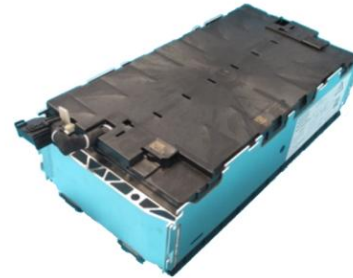


- Modular kit HW: same electronic components in both systems
- Modular kit SW: same software and algorithms in both systems, diversity by calibration
- BMU (Battery Management Unit), S-Box (Switch Box) and CSC (Cell Supervising Circuit)
- BMU contains battery management software (e.g. SOC, SOH, diagnosis)
- CSC for cell voltage/temperature measurement
- S-Box: fuse, contactors, current and voltage measurement

TECHNICAL CONCEPT – CELL MODULE.



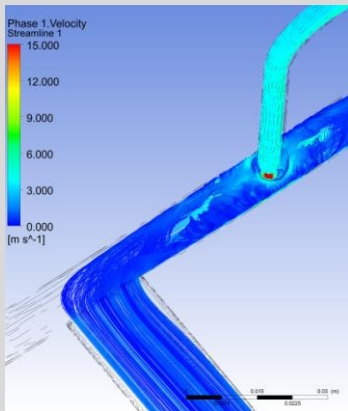
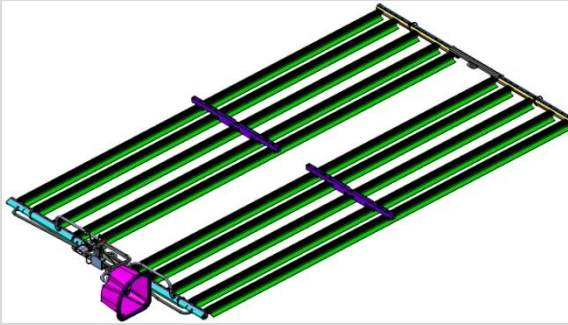
EV cell module (12 cells)



PHEV1 cell module (16 cells)

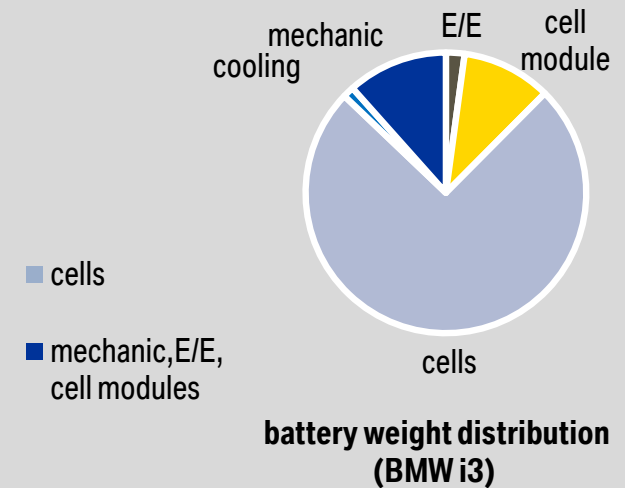
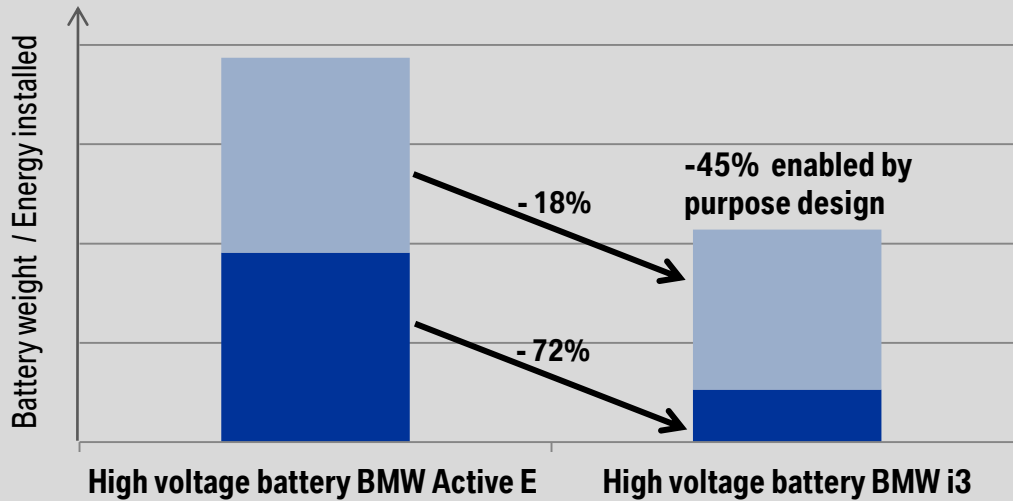
- Cell number per module (12 v.s. 16) : trade-off between package, electronic components and transport regulations
- Cell module is a serviceable unit
- Validation on module level guarantees high quality and reduced costs for derivatives
- Meeting UN38.3 standard
- Possibility to use EV and PHEV1 modules for further projects

TECHNICAL CONCEPT – REFRIGERANT COOLING.



- **Cell Lifetime**
Cooling performance is key factor for lifetime
- **Weight & performance**
Highest cooling performance at minimum weight and costs (no extra installation in vehicle, use of existing A/C system)
- **Heating option**
Available for maximum comfort and performance without losing range
- **Complexity of direct cooling**
Intensive validation and simulation is necessary for complex designs (multi-layer)

LIGHTWEIGHT – A KEY FACTOR FOR FUTURE BATTERY SYSTEMS.



Electric range for EV (based on BMW i3):

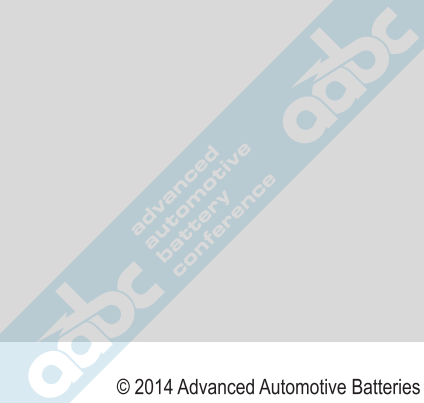
Today:

160km / 100miles

Target (2025):

480km / 300miles

* targets based on battery pack 250Wh/kg / 450Wh/lt [P. Lamp, ABAA 6, Chicago 2013]



SUMMARY.

- BMW i as a holistic approach to sustainable mobility
- In-house development of high voltage batteries in third generation
- Purpose design vehicle architecture allows ideal integration in terms of weight & costs
- Powerful, long-lasting and safe high voltage batteries
- Modular kit approach, possibility of use for further electric powertrains at BMW

